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Description

HEAD-MOUNTED DISPLAY AND OPTICAL ENGINE THEREOF

BACKGROUND

[0001] Field of the Invention

[0002] The present invention relates to a head-mounted display (HMD) and the optical engine thereof and more specifically to a head-mounted display capable of showing images formed by means of an LCoS (liquid crystal on chip) device.

[0003] Description of the Related Art

[0004] In recent years, virtual reality, a type of computer simulation technology, has been vigorously developed, and can make wearers temporarily feel that they exist in the three-dimensional (3D) space of a simulated world. Through a head-mounted display, the imitative voices and images are sent directly to the sense organs of the wearer. Due to previous practical experiences, the wearer would really

think of these imaginary imagines as real ones. Currently, such apparatus has been widely applied in computer games. If a space positioner and a 3D joystick are added to the apparatus, there would be feeling of truer reality.

[0005] In addition to being the standard apparatus of virtual reality, the head-mounted display may be used to further replace the display of a TV or a computer. Furthermore, it is also an optimal solution for privacy when one uses a notebook in public place to avoid peeping of the others. Also, many workers who constantly move about, for example, researchers, soldiers or stockjobbers, need to complete their works by wearing a head-mounted display.

[0006] In as early as the 1960s, a professor from the University of Utah, the USA, formed the first head-mounted display with a cathode ray tube monitor, an optical system intended for focusing, and a computerized image creation unit, wherein the process of displaying signals on the screen was controlled by means of rotation of head. Afterward, thin film transistor liquid crystal display (TFT-LCD) was applied to head-mounted displays, and thus head-mounted displays became lighter and have been used increasingly in fields like entertainment, medicine, education, etc.

[0007] Recently, the technology of miniaturized LCoS displays has forged into maturity, and the miniaturized LCoS displays have been applied to the image generator used in head-mounted displays. The principle of manufacturing LCoS displays is as follows: form an active matrix driving circuit for driving liquid crystal materials on silicon substrate with a CMOS manufacturing process, and stack a liquid crystal layer and a glass plate on the silicon substrate to form an LCoS display. A light source emits a ray that enters the liquid crystal layer through the glass plate and returns to the upper surface of the glass plate by reflection, and eventually the LCoS display reflects the predetermined image. Hence, LCoS displays are also known as reflective liquid crystal displays. Since LCoS displays have a relatively high aperture ratio, luminance, resolution and contrast, and the equipment for their manufacturing process is relatively common, LCoS displays will be the mainstream image generators for head-mounted displays.

BRIEF SUMMARY

[0008] The objective of the present invention is to provide a head-mounted display and its optical engine, wherein images are formed by means of an LCoS device, and interfering rays are filtered out by means of the relative posi-

tions of a light source and a polarizer so as to secure good imaging quality.

[0009] In order to achieve the objective, the present invention discloses a head-mounted display and an optical engine thereof. The head-mounted display comprises monocular or binocular display chambers. Each display chamber is equipped with an optical engine that displays images. The mechanism of the optical engine is as follows: cast rays from a light source onto an LCoS device through a first polarizer, and an image is formed with rays, which reflect off the bottom of the LCoS device. The reflective rays penetrate the first polarizer and a film-coated beam splitter. With a concave mirror, the image is magnified and projected onto the surface of the beam splitter. Finally, the magnified image is formed in a viewer's eyeballs by means of the beam splitter.

DESCRIPTION OF THE DRAWINGS

[0010] The invention will be described according to the appended drawings in which:

[0011] FIG. 1 is a perspective diagram of the head-mounted display in accordance with the present invention;

[0012] FIG. 2(a) is a schematic diagram of the optical engine in accordance with the first embodiment of the present in-

vention;

[0013] FIG. 2(b) is a magnified diagram of the portion B in FIG. 2(a);

[0014] FIG. 3 is a schematic diagram of the optical engine in accordance with the second embodiment of the present invention; and

[0015] FIG. 4 is a schematic diagram of the optical engine in accordance with the third embodiment of the present invention.

DETAILED DESCRIPTION

[0016] FIG. 1 is a perspective diagram of the head-mounted display in accordance with the present invention. The head-mounted display 1 comprises the display chambers 2 intended for the right eye and the left eye respectively, though its alternative design may have one single display chamber 2 intended for users who move about during work time. An optical engine 3, which creates images, is installed in each display chamber 2. With both eyes close to the display chambers 2, a user 8 browses various pictures displayed by the head-mounted display 1. In addition to the display chambers 2, the frame 5 of the head-mounted display 1 may be equipped with an earpiece 4 to make the head-mounted display more useful.

[0017] As shown in FIG. 2(a), the optical engine 3 essentially comprises an optical system composed of an LCoS device 12, a light source 16, a first polarizer 13, a beam splitter 14 and a concave mirror 15. The LCoS device 12 is installed on a circuit board 11. The light source 16 is obliquely fixed on the circuit board 11. The first polarizer 13 reflects part of the rays emitted by the light source 16 so that the reflective rays fall on the LCoS device 12, then the LCoS 12 reflects the rays which form a specific image so that they fall on the first polarizer 13. Part of the rays penetrate the first polarizer 13 and reach the beam splitter 14. Owing to a coated film on the surface of the beam splitter 14, incident rays are sent to the concave mirror 15 below by refraction, and the rays backwardly reflect off the concave mirror 15 and then travel in the direction of an analyzer 17.

[0018] The concave mirror 15 magnifies the image and sends it to the surface of the film-coated beam splitter 14 by reflection, and then the magnified image reflects off the beam splitter 14 and is finally formed in the eyeballs 80 of a user 8. As a result, the user 8 is able to watch the magnified image displayed by the optical engine 3 and centered at a visual axis 18 in a way comparable to the large-

screen effect of an ordinary desktop monitor. The concave mirror 15 adopted in the present invention will magnify images to a greater extent and display images better, if it is non-spherical in shape. The analyzer 17 lying between the beam splitter 14 and the eyeballs 80 filters out stray light, making the images entering the eyeballs 80 softer.

[0019] FIG. 2(b) is a schematic diagram of the magnified part B shown in Fig. 2(a). A 20°±5° included angle between the luminous surface of the light source 16 and the surface of the LCoS 12, coupled with a 30°±5° included angle between the first polarizer 13 and the surface of the LCoS 12, makes the optimal relative relationship, eliminating undesirable images like ghosting. The light source 16 comprises a light generator 161, a pre-polarizer 162 and a Fresnel lens 163. In general, the light generator 161 can be a tri-color RBG LED. The purpose of the pre-polarizer 162 is to absorb polarized light that travels in a certain direction but permit the passage of polarized light that travels in a different direction. The Fresnel lens 163 turns the passing rays into parallel rays and enables even distribution of light intensity.

[0020] FIG. 3 is a schematic diagram of the second preferred embodiment of the optical engine put forth in the present in-

vention. Unlike FIG. 2, FIG. 3 shows a first polarizer 13' found in a position parallel to the beam splitter 14 instead of its previous position, a light source 16' lying to the right of the first polarizer 13', and the parallel rays emitted from the light source 16' falling on the first polarizer 13' at an incident angle of 45° approximately. The first polarizer 13' reflects part of the light emitted by the light source 16' so that it falls on the LCoS device 12. The LCoS device 12 then reflects the rays which form a specific image, so that the rays return to the first polarizer 13'. Part of the rays penetrate the first polarizer 13' before they reach the beam splitter 14. Owing to a coated film on the surface of the beam splitter 14, incident rays are sent to the concave mirror 15 below by refraction, and the rays backwardly reflect off the concave mirror 15 and then travel in the direction of an analyzer 17. In terms of its function, the first polarizer 13' may be directly incorporated into the beam splitter 14, that is, a polarizing beam splitter may substitute for the beam splitter 14 and the first polarizer 13'.

[0021] FIG. 4 is a schematic diagram of the third preferred embodiment of the optical engine put forth in the present invention. As shown in FIG. 4, both the concave mirror 15

and the LCoS device 12 are installed on the same side of the beam splitter 14'. The first polarizer 13 reflects part of the light emitted by the light source 16 to send it to the LCoS device 12. The LCoS 12 then reflects the rays that form a specific image, so that the rays return to the first polarizer 13. The rays that form the specific image penetrate the first polarizer 13 before they reach the beam splitter 14'. Owing to a coated film on the surface of the beam splitter 14', incident rays are sent to the concave mirror 15 on the right side by refraction, and the rays backwardly reflect off the concave mirror 15 and then travel in the direction of the analyzer 17.

[0022] The above-described embodiments of the present invention are intended to be illustrative only. Numerous alternative embodiments may be devised by persons skilled in the art without departing from the scope of the following claims.